

**REMARKS**

This Preliminary Amendment cancels, without prejudice, claims 1 to 10 in the underlying PCT Application No. PCT/EP03/01600 and adds new claims 11 to 22. The new claims, inter alia, conform the claims to United States Patent and Trademark Office rules and does not add any new matter to the application.

In accordance with 37 C.F.R. § 1.125(b), the Substitute Specification (including the Abstract) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to United States Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(ii) and 1.125(c), a Marked-Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) are respectfully requested.

The underlying PCT Application No. PCT/EP03/01600 includes an International Search Report, dated June 4, 2003, a copy of which is included. The Search Report includes a list of documents that were considered by the Examiner in the underlying PCT application.

The underlying PCT Application No. PCT/EP03/01600 also includes an International Preliminary Examination Report, dated November 28, 2003. An English translation of the International Preliminary Examination Report is included herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

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[11839/32]

RACK-AND-PINION STEERING SYSTEM FOR MOTOR VEHICLES

FIELD OF THE INVENTION

The present invention relates to a rack-and-pinion steering system for motor vehicles, whose the rack of which is mounted in a housing such that it is longitudinally displaceable, is connected at both ends to in each case one steering rod in an articulated manner, sealing bellows being fastened on one side to the housing and on the other side to the longitudinally displaceable steering rods. Said The bellows made from a flexible material serve to protect the articulated connection and the rack against dust, other solid bodies and humidity.

BACKGROUND INFORMATION

During driving operation, what is known referred to as a pump effect occurs on account of the axial displacement movement of the rack, said the pump effect widening the bellows as a result of the intake of air but also as a result of temperature-induced air expansion, and therefore subjecting them to an additional load. Secondly, a reduced pressure compared with atmosphere can occur in the bellows, which can lead to the annular folds bending inward. ~~A means of inwardly.~~ A device for compensation must be provided for the changes in volume occurring in the bellows or also within the housing.

DE German Published Patent Application No. 29 00 026 e3 describes a ventilation apparatus for a shaft joint having bellows sealing, which has a slotted sleeve as a flow connection which is integrated between the shaft and the fastening sleeve of the bellows and allows air to pass. A disadvantage of such a solution is that, in the event of a wet roadway, water and dirt can penetrate through this opening into the joint space as a consequence of the proximity of the

wheel and heavy occurrence of water spray, and therefore the components to be protected are subjected to increased wear.

US S. Patent No. 3,927,576 ~~discloses~~ describes an articulated connection protected by a bellows, in which this disadvantage is eliminated by integrating solids filters in the fastening collar of the bellows or in adjoining regions of, the housing, which filters, in addition to pressure compensation between the interior and atmosphere, also prevent the penetration of moisture and dirt. However, a change to the bellows is necessary here, so that specially manufactured bellows become necessary rather than the commercially available ones. The integration of the solid body filter in special ventilation openings of the housing permits subsequent installation into steering systems which are already in service only in conjunction with increased expenditure.

#### SUMMARY

According to an example embodiment of the present invention, the invention specified in patent claim 1 is based on the problem of designing a rack-and-pinion steering system of the type specified at the outset is provided, in which the required pressure compensation between the interior of the bellows or of the steering mechanism housing and atmosphere is may be ensured and, independently of the respective deployment situation and loading of the bellows, reliable sealing of the same can be achieved. The problem is solved by the feature which is specified in the characterizing part of patent claim 1, in that the may be achieved. A pressure compensation element is may be integrated in the pressure piece which keeps the rack in constant engagement with the pinion.

The advantages which are achieved with the invention consist, in particular, in that the components to be protected are may be reliably sealed using a simple means arrangement and with continuous pressure compensation, and the properties of their

translational movement may remain preserved without changes to the elastic bellows or to the steering mechanism housing becoming necessary.

5 ~~Advantageous developments are specified in the dependent claims.~~

One exemplary embodiment of the invention is shown in the drawing and explained in the following text in greater detail.  
10 ~~in the drawing.~~

fig. 1 shows a diagrammatic representation of the design of an electrically assisted power steering system;

15 ~~fig. 2 shows a sectional representation having a According to an example embodiment of the present invention, a rack-and-pinion steering system for motor vehicles includes: a pinion; a rack longitudinally displaceably arranged in a steering mechanism housing, the rack including two ends, each end articulatedly connected to a respective steering tie rod; a pressure piece configured to maintain the pinion and the rack in constant engagement; a sealing bellows fastened on one side to the housing and on another side to the steering tie rods; and at least one pressure compensation element integrated in a pressure piece. the steering mechanism housing, the pressure compensation element integrated in the pressure piece.~~

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Although the According to an example embodiment of the present invention, a rack-and-pinion steering system for motor vehicles includes: a pinion; a rack longitudinally displaceably arranged in a steering mechanism housing, the rack including two ends, each end articulatedly connectable to a respective steering tie rod; a pressure piece configured to maintain the pinion and the rack in constant engagement; a sealing bellows fastened on one side to the housing and

fastenable on another side to the steering tie rods; and at least one pressure compensation element integrated in the steering mechanism housing, the pressure compensation element integrated in the pressure piece.

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According to an example embodiment of the present invention, a rack-and-pinion steering system for motor vehicles includes: pinion means; rack means longitudinally displaceably arranged in a steering mechanism housing means, the rack means including two ends, each end articulatedly connected to a respective steering tie rod means; means for maintaining the pinion means and the rack means in constant engagement; sealing bellows means arranged on one side to the housing means and on another side to the steering rod means; and at least one pressure compensating means integrated in the steering mechanism housing means, the pressure compensating means integrated in the maintaining means.

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An exemplary embodiment of the present invention is illustrated in the appended Figures and explained in the following text in greater detail.

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#### BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view of an electrically assisted power steering system.

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Fig. 2 is a cross-sectional view of a pressure compensation element integrated in a pressure piece.

#### DETAILED DESCRIPTION

Although an example embodiment of the present invention is described using with reference to a rack-and-pinion steering system 1 having electrical power assistance, it can may also be used in rack-and-pinion steering systems 1 having hydraulic

power assistance or without power assistance or in steering systems having external power assistance, etc.

In a rack-and-pinion steering system 1 of this type, a pinion 9 bears an input shaft 2 which, in the exemplary embodiment according to fig illustrated in Fig. 1, is operatively connected to a steering wheel 4 via a steering column 3 provided with universal joints. Together with two steering rods 5 and 6 whose articulated connections to the rack 12 are enclosed in a protective manner by the bellows 19 and 20, the rack of the rack-and-pinion steering system 1 forms on the output element which is operatively connected to wheels (not shown) which are to be steered. Moreover, the rack 12 forms the driven part of the steering system. Using a power assisted steering system of this type, it is possible to transmit the steering torque from the steering wheel 4 to the wheels to be steered. An assisting force ~~can~~ may be exerted on the input shaft 2 by an electric motor 7. In this exemplary embodiment, the electric motor 7 is arranged ~~in~~ such a way that its axis is perpendicular with respect to the axis of the input shaft 2 and therefore of the pinion (9). However, it is also possible for its axis to be at a different angle to the axis of the input shaft 2, for example at an angle of from 60° to 130°.

With an identical or similar effect, the electric motor 7 ~~can~~ may be arranged ~~in~~ such a way that its axis is arranged parallel to the axis of the input shaft 2 and therefore of the pinion 9 or parallel to the axis of another part of the steering column 3.

In the two previously described ways manners of arranging the electric motor 7, the latter acts on the input shaft 2 and the pinion 9 of the rack-and-pinion steering system 1. It is likewise possible for the electric motor 7 to be arranged ~~in~~ such a way that its axis lies is parallel to, or at an angle

to, or coaxially with respect to the axis of the rack 12 of the rack-and-pinion steering system 1.

5 In the sectional cross-sectional representation according to fig view illustrated in Fig. 2, a pinion 9 is rotatably mounted in two bearings 10 and 11. The toothing of the pinion 9 engages with a rack 12 which is guided in the steering housing 8 in an axially displaceable manner. The rack 12 is  
10 may be pressed against the toothing of the pinion 9 in a known conventional manner using a spring-loaded pressure piece 13.

15 The rack 12 has a longitudinal groove 16 in its toothing region on the outer circumferential surface on the opposite side from the toothing. The longitudinal groove 16 interacts with a longitudinal lug 17 which is integrally formed on the pressure piece 13. The rack 12 is prevented from tilting during operation by the interaction of the longitudinal groove 16 and the longitudinal lug 17. It is possible for these two elements to be interchanged with an identical effect, so that  
20 the longitudinal lug is arranged on the rack 12 and the longitudinal groove is arranged on the pressure piece 13

25 A pressure compensation element 14 designed to be air and liquid permeable is integrated in the adjusting screw 18 of the pressure piece 13 for pressure compensation in the interior of the mechanism housing 8 of the rack-and-pinion steering system 1. The adjusting screw 18, designed here arranged as a screw cap, serves to adjust the play of the pressure piece, which play can may be adjusted by the amount  
30 by which the screw cap is screwed in.

35 By way of For example, the pressure compensation element 14 is configured as a porous sintered plastic insert which is arranged in a cutout 15 of the adjusting screw 18, said the cutout 15 being adapted to the dimensions of the sintered plastic insert.

The sintered plastic insert is configured as a pressed pellet composed of PTEE material. Here, the pressed pellet is formed from ground granules which are present, for example, in the form of small balls, the granules being joined to one another under pressure and temperature. The varied density of the sintered material, which is may be critical for the air permeability value, ~~can~~ may be influenced ~~here~~ in a simple manner by the size and/or shape of the granules.

Here, the air permeability of the pressed pellet decreases in a manner corresponding to the magnitude of the applied pressing pressure. The property of the pressed pellet of allowing air to permeate and preventing the penetration of moisture ~~can~~ may therefore be determined in a particularly simple manner by the granules or the pressure and the temperature of the sintering process.

The pressure compensation element 14 ~~can~~ may also be composed of another sintered material, such as sintered bronze or another moisture tight and air permeable solids filter which ~~can~~ may be configured as a thin disk or diaphragm.

~~In an application which is not shown, the~~ The entire adjusting screw 18 ~~is~~ may be composed of porous sintered material.

The introduction of a pressed pellet into the adjusting screw 18 if the pressure piece 13 ~~makes~~ may make it particularly simple to retrofit a pressure compensation element 14 to a steering mechanism 18 already in service, by exchanging the existing adjusting screw for one having a pressure compensation element 14.

Abstract:

**ABSTRACT**

~~Rack-and-pinion steering system for motor vehicles~~

5 The invention relates to a rack-and-pinion A rack-and-pinion steering system (1) for motor vehicles, whose includes a rack (12), which is mounted in a housing (8) such that it is longitudinally displaceable and kept in constant engagement with a pinion (9) by a pressure piece (13), is connected at 10 both ends to in each case one steering tie rod (5, 6) in an articulated manner, sealing bellows (19 and 20) being fastened on one side to the housing (8) and on the other side to the longitudinally displaceable steering rods (5, 6), and which. The steering system (1) has a pressure compensation element 15 (14) integrated in the pressure piece (13).

Figure 2

~~List of reference numerals used~~

**LIST OF REFERENCE NUMERALS USED**

		Rack-and-pinion steering system
		Input shaft
5	3	Steering column
	4	Steering wheel
	5	Steering rod
	6	Steering rod
	7	Electric motor
10		Steering housing
		Pinion
		Bearing
		Bearing
		Rack
15		Pressure piece
		Pressure compensation element
		Cutout
	16	Longitudinal groove
	17	Longitudinal lug
20		Adjusting screw
		Bellows
	20	Bellows